Composites detect THz rays for new imaging tools

A team of physicists and engineers from the University of California, San Diego, University of California, Los Angeles and Imperial College, London have developed a class of materials that respond magnetically to terahertz radiation, a finding relevant to many exciting applications in areas including guidance in zero visibility weather conditions, security, biomedical imaging and quality control. The metamaterials are artificially structured to extend the properties of existing naturally occurring materials and compounds. In 2000, UCSD researchers created and reported the first measurements of left-handed metamaterials - so called because they reverse many of the physical properties that govern the behaviour of ordinary materials. Left-handed materials (see page 26) were named in the Top Ten scientific breakthroughs of the year by *Science* last December, when the materials and their properties were independently confirmed by multiple groups. While not left-handed, the present metamaterials demonstrate that the magnetic response can be extended to much higher frequencies, namely the terahertz range, a set of frequencies that are intermediate between infrared and microwave rays.

"When we developed the initial left handed materials that responded in the microwave range, we were not certain if it were technically feasible to develop materials that responded to higher frequencies," says David Smith, co-author and associate adjunct professor in UCSD's physics department.

"This is a particularly exciting advance. There are very few natural materials that respond magnetically in the terahertz range."

The material designed by the researchers consists of a 2D array of repeated patterned copper elements, called split ring resonators, deposited on a quartz plate. Each split ring resonator is made up of two concentric copper squares, both having a small gap. The gap in the larger square is on the opposite side to the gap in the smaller square.

The width of one of the split ring resonators is roughly 50 microns. While copper is not magnetic, the geometry of the resonator leads to an effective magnetic response, so that the composite metamaterial can be characterised as magnetic. Therefore, these engineered metamaterials have properties that are not observed in their constituent materials.

Left to right: Lord Sainsbury presents top prize to Dr Jonathan James. The winner of the Research Councils' Business Plan Competition, with a top prize of £25,000, was awarded to ThruVision Ltd of the Rutherford Appleton Laboratory in Oxfordshire, led by Dr Jonathan James.
ThruVision is developing an innovative THz imaging technology, initially for security screening products. A working prototype has successfully imaged guns and explosives hidden under clothing; concealed body armour and various other concealed metallic and non-metallic objects.
This is the first time that all seven of the UK's Research Councils and the Arts and Humanities Research Board have joined together to run the competition under the banner of Research Councils UK.